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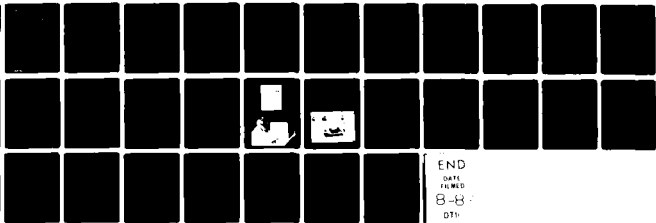
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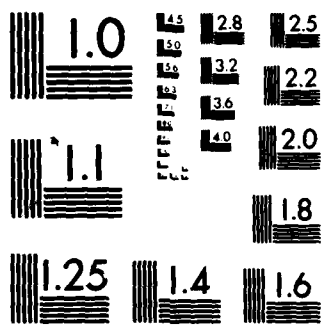
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CAUSE RELATIONSHIPS OF COLLISIONS AND GROUNDINGS PROJECT RESULTS AND CONCLUSIONS

By

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Presented at

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Abstract

The project was initiated in 1977 with the objective of recommending measures to reduce the number of casualties.

The project tasks have been model and method development, analysis of about 3000 collisions and groundings, development of a manoeuvring simulator, near-miss analysis and evaluation of the idea of a data recorder for ships. The project has large support in the maritime society and a budget of 5.1 mill. NOK for the 4 year period ending this year. The recommended measures will vary for different ship sizes, and cover the areas of navigational aids, bridge systems, ship technology, personnel/competence and bridge procedures. Other important results are a casualty data system, a manoeuvring simulator, concepts on accident investigation and basis for educational material. Some general observations on international work for safety at sea will be mentioned.

Indexing terms:

Collisions
Groundings

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1. INTRODUCTION

IMCO last year's casualty statistics, analysing serious casualties to ocean-going tankers (1968 - 1979), conclude, inter alia, that the number and incidence rate of serious casualties for 1979, was the highest since the system was initiated in 1968. This is alerting, but perhaps not suprising. Because, when comparing with the airline industry, the lack of a safety philosophy in shipping is notable, and there should be no reason why the demands on safety concerning air traffic should not be required for traffic at sea.

1.1 A shipping safety philosophy

The following thoughts are inspired by an air traffic safety program:

The idealistic objective should be:

I To avoid ship casualties



However, in the real world this have to be modified:

II To avoid ship casualties leading to high consequences

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Where the consequences are measured by:

- people injured or killed
- pollution
- loss of or damage to ship and cargo

The need for definition of a casualty is necessary:

III Casualty is a symptom of malfunction of the organizing system which is responsible for coordination of all activities contributing to safety

with organizing meaning:

- IV Organizing is to get things done by help of people who cooperate towards a mutual goal

A good organizing system is based on good leadership, where the leader is motivating and stimulating people to act and think to avoid casualties.

The term "human error" is entering the picture at this stage, because "human error" is quoted as the dominating cause to ship casualties.

Therefore, to continue these thoughts, the following may be claimed:

- V The "human error" can be traced back to unsufficient leadership within planning, organization and control

This may be felt as an unfair simplification of the problem. But the meaning is that we can learn from accidents, and that it must be the responsibility of management to identify elements of risk and build up and inform about the safety program.

The conclusion of these thoughts about a safety philosophy is:

- VI Casualties happens because of "human errors" which can be traced back to unsufficient coordination and operation of the activity

Therefore, the obvious measure must be:

- VII A system or program must be defined, which minimize the "human error"

1.2 The project approach

The project "Cause Relationships of Collisions and Groundings" should be evaluated on the background of the preceeding thoughts.

Fig. 1 illustrates the project approach, that the total picture must be evaluated when explaining a ship casualty, i.e. the ship system, the contribution from the environment and the society behind.

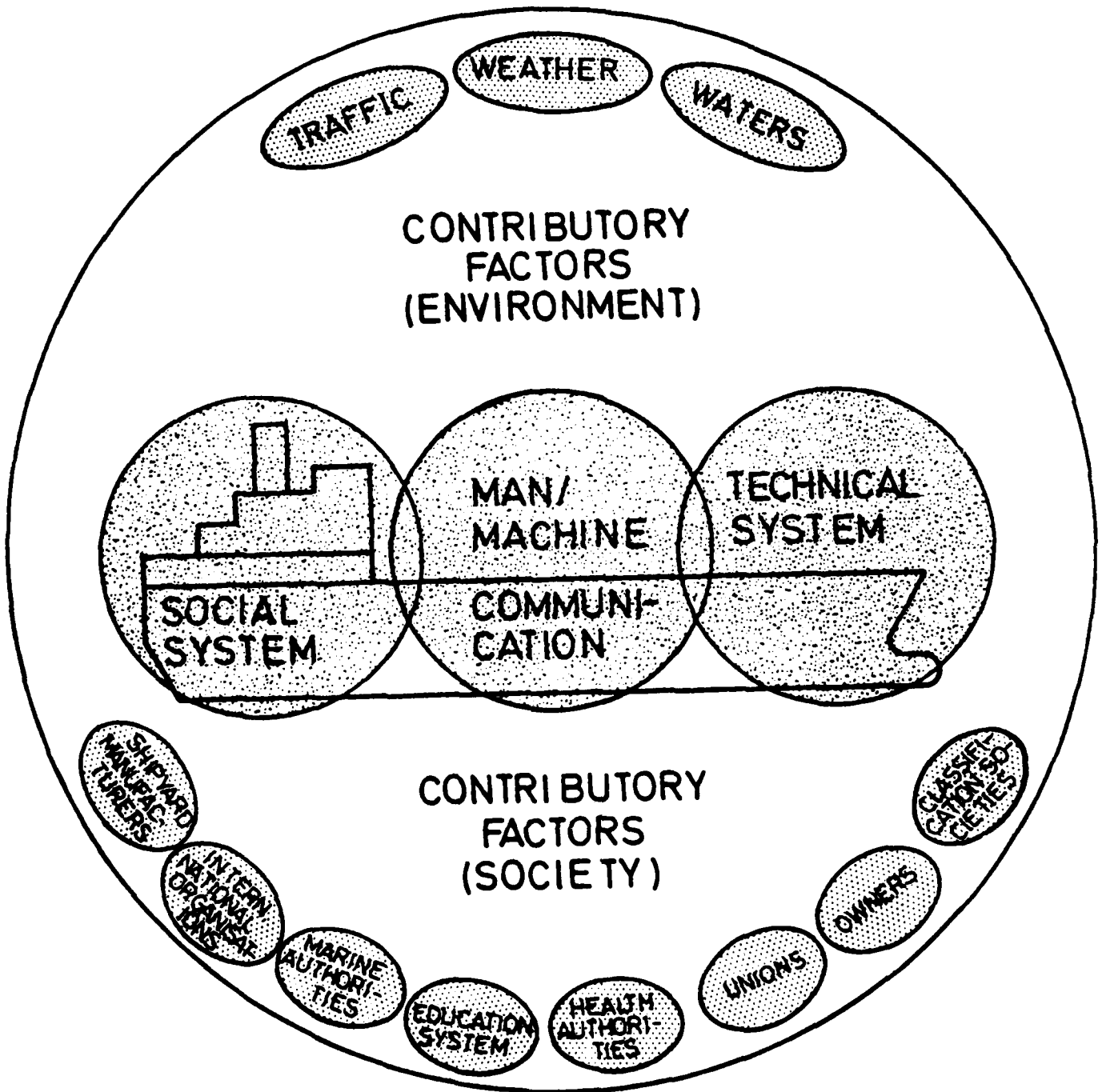


ILLUSTRATION
OF
PROJECT

Fig. 1

The analysis was limited to the most dominating group of ship casualties, namely collisions and groundings, which for Norwegian ships for the period 1970-78, constitutes about 75% of all reported casualties as shown in Fig. 2.

NORWEGIAN SHIP CASUALTIES 1970-1978

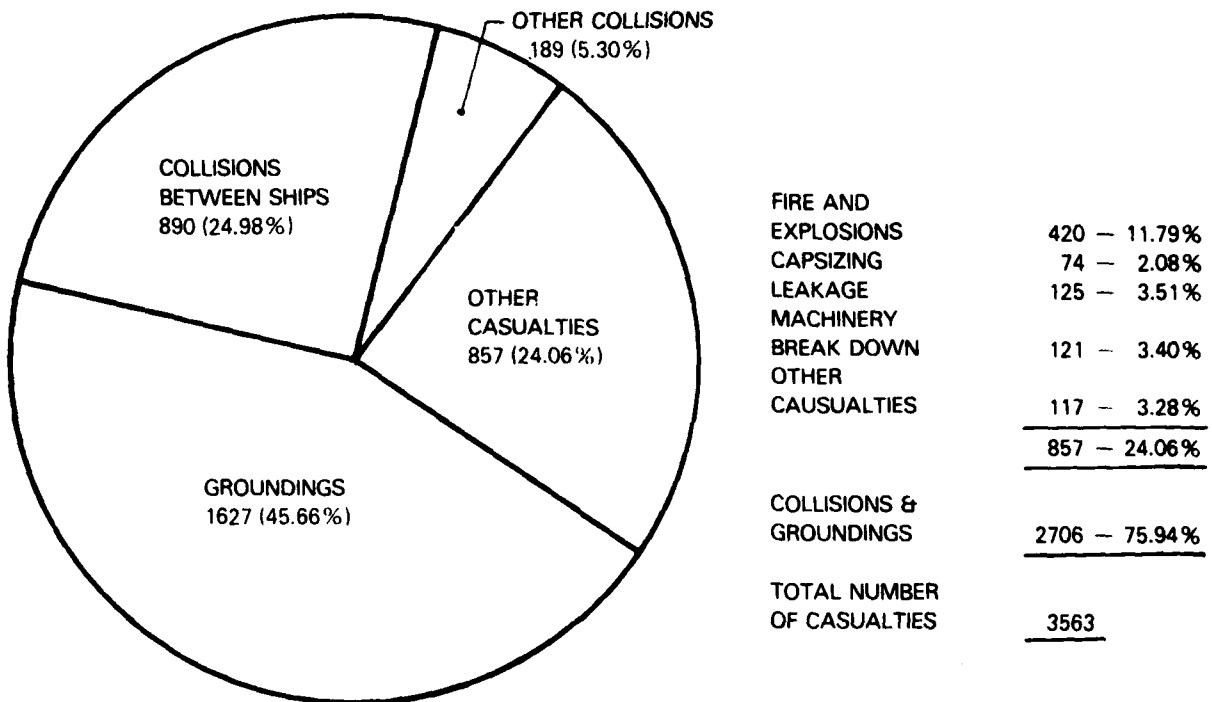


FIG. 2

The research approach was:

VIII to learn from accidents

This seemed best achieved by analysing accidents to find the causal relationships:

IX A causal relationship is a set of incidents, which under the given operational conditions, constitutes the defects of the system, and which generate the accident

On this background the project's main objective was formed:

Through studies of the error mechanism in manoeuvring and navigating which leads to collisions and groundings, recommend means which will reduce the accident frequency.

Based on this the following goals was set up:

1. Through review and evaluation of marine casualty statistics, develop detailed statistics of collisions and groundings, describing the incidents and possible causes.
2. Through analysis of collisions and groundings, develop an investigating and reporting scheme, which gives an improved explanation of the causes of the accidents.
3. Through development of models and methods for the analysis of collisions and groundings, arrive at qualitative and quantitative descriptions of accident causes.
4. Through socio-technical and ergonomic studies arrive at qualitative and quantitative descriptions of man/machine communication on a ship bridge.
5. Through analysis of ship manoeuvring characteristics and the limitations due to ship size, equipment, manning and environment, arrive at an explanation of the ship system as a contributory causal factor.
6. Through manoeuvring and navigation simulation, to test models and methods, and evaluate use of simulation for analysis of casualties and for instruction of personnel.
7. Through follow-up studies and data collection onboard, try out project ideas, and investigate near-misses.
8. Implement and employ project results internationally through rules and recommendations; develop educational programs and propose development of new equipment.

2. THE COLLISION/GROUNDING PROBLEM

The project's main objective is to recommend measures which can reduce the number of accidents. To arrive at conclusions it is therefore necessary to see the relation between measures and the collision/grounding problem. This might be illustrated as shown in Fig. 3.

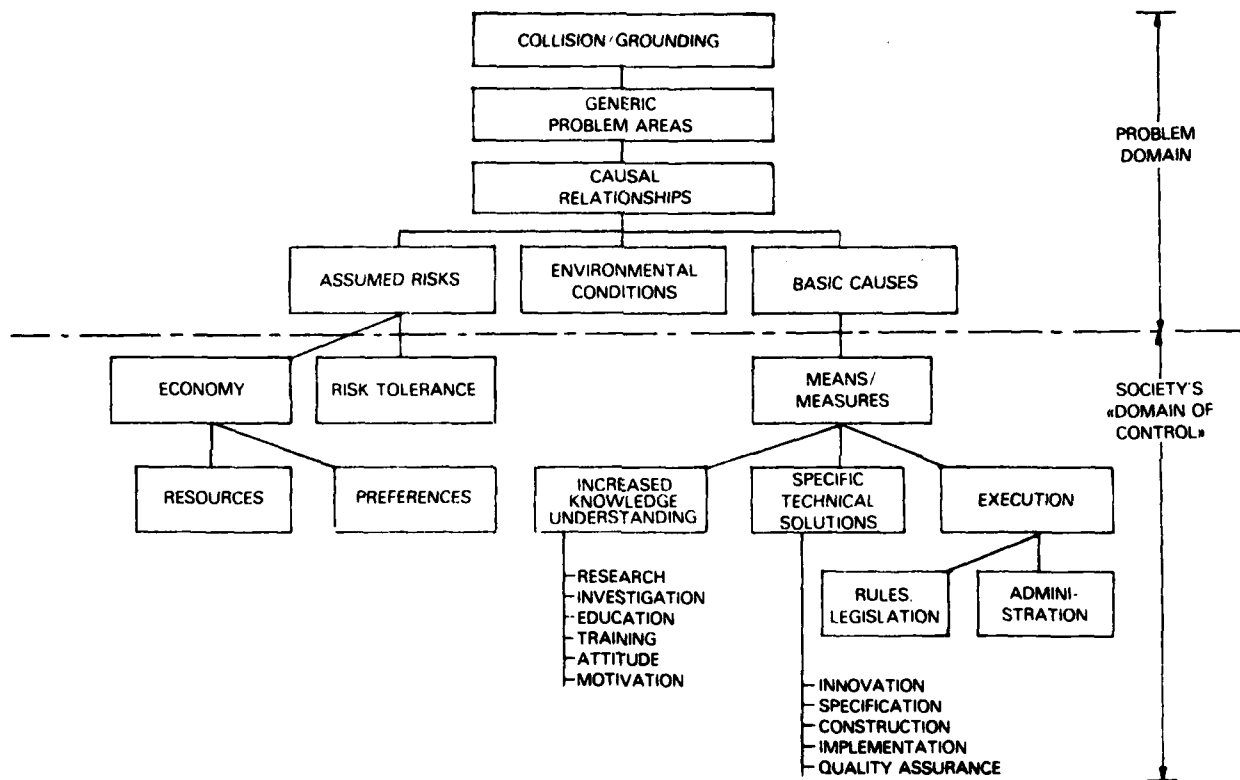


FIG. 3

It seems reasonable to group the factors in a causal relationship in two:

- basic causal factors
- situation determined factors

Basic causal factors may be weakness in:

- planning
- organization
- administration
- judgement
- execution
- technical aids

This group of causal factors might be easily influenced in practice, in that one can point out concrete measures that will reduce or eliminate these weaknesses.

The figure indicates measures like:

- increased knowledge
- technical solutions
- rules and regulations

Situation determined factors is:

- factor which must be looked upon as given boundary conditions for the sailing operation due to technical, economical, operative or physical reasons.

As an example, "dense fog" will be a situation dependent factor and must be given as a given boundary condition with which the navigator should comply by maintaining the performance level required when sailing in fog.

These factors may be characterized as "assumed risks" and are dependent on economy and risk tolerance.

However, for these factors it will be a question of improving the standard of operation, and by that reducing the risk.

For the example above, radar reflectors or racons will reduce the risk of sailing in "dense fog".

However, it is important to underline that recommendations on safety measures are also a question of economy, and that the society is setting the risk level when giving priority to the different means.

This analysis is only concentrating on causal relationships and are not investigating the cost and consequences of the accidents.

The casual relationships leading to the accidents are in many cases identical, for serious and none serious casualties, and the cost is therefore indifferent in this analysis.

The consequences after the accident are in many cases a question of the emergency plan onboard and the crew's familiarity with it. This will not be covered in the project.

2.1 The project tasks

To achieve the project goals, an interdisciplinary approach was felt necessary. Therefore, in the project pilot study, eleven (11) project tasks were identified.

- Statistics

Review and evaluate existing statistics to understand their limitations and arrive at better statistical presentations of collision and grounding accidents.

- Casualty Analysis

Analyse and code a great number of previous and new accidents to achieve a more differentiated statistical presentation of possible causes.

- Case Studies of Casualties

Study certain accidents in depth.

- Development of Models and Methods

Develop and refine different methods like fault-tree, and failure-mode and effect analysis for utilization in casualty analysis.

- Critical Events

Develop a reporting scheme for near-misses.

- Ergonomics and Man/Machine Communication

Totally review the navigator's job situation.

- Bridge Instrumentation and Layout
Evaluate design deficiencies as a causal factor in accidents.
- Manoeuvring Properties
Find time margin and limitations in critical situations, due to ship hydrodynamic properties.
- Simulation
Evaluate results through simulation studies.
- Black-box
Study the feasibility of using a data recorder (black-box) as in air-planes.
- Registration on Board
Propose registration and follow-up systems on board to evaluate project results.

This broad approach was necessary to identify those tasks which were found to be most important, and which the project team should concentrate upon.

In this reduction process, the below list of goals were decisive for the final working tasks:

- Focus interest and debate on casualties
- Achieve cooperation with/between maritime institutions and authorities
- Enlighten the problem area
- Think internationally
- Achieve results which are useful to the maritime society and implement them during project lifetime

Fig. 4 shows the resulting working tasks.

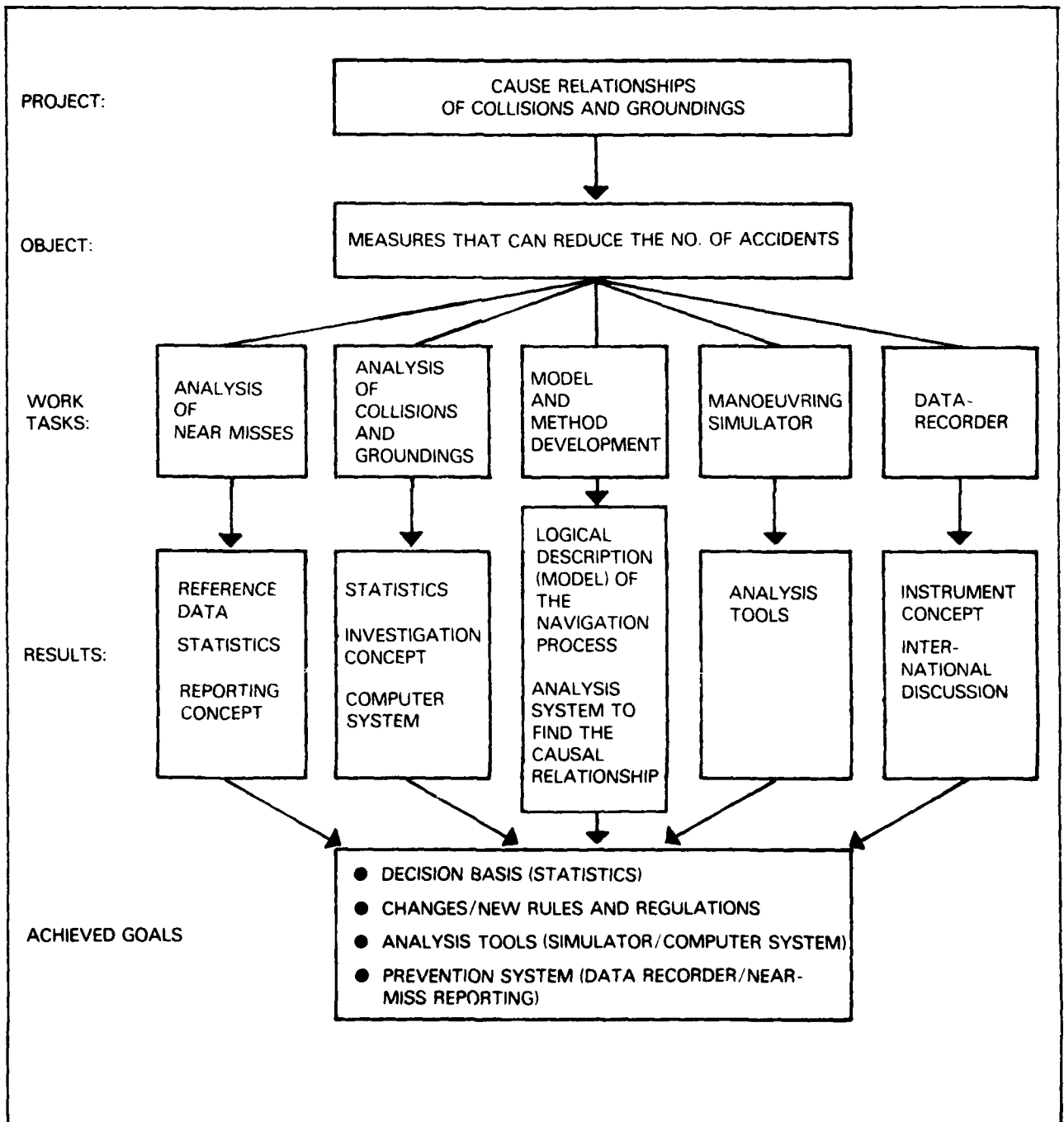


FIG. 4

3. MODEL AND METHOD DEVELOPMENT

The very problem in analyzing a shipping accident with respect to its causes is not to identify the list of causal factors but to show the unique interactive, dynamic interaction between normal events, conditions, errors, misjudgements and malfunctions eventually leading to the mishap. In order to reveal characteristic patterns in the complexity of details from accident to accident so as to direct safety measures efficiently, a common analytic approach is needed.

This commonality is provided by a detailed model of the navigation process, where all human tasks and technical functions necessary to direct the movement of the vessel safely are described. This operational model of the ship system consists of the three basic elements: ship, waterway and navigation process, focusing on the information processing and decisionmaking aspects of navigation, see Fig. 5.

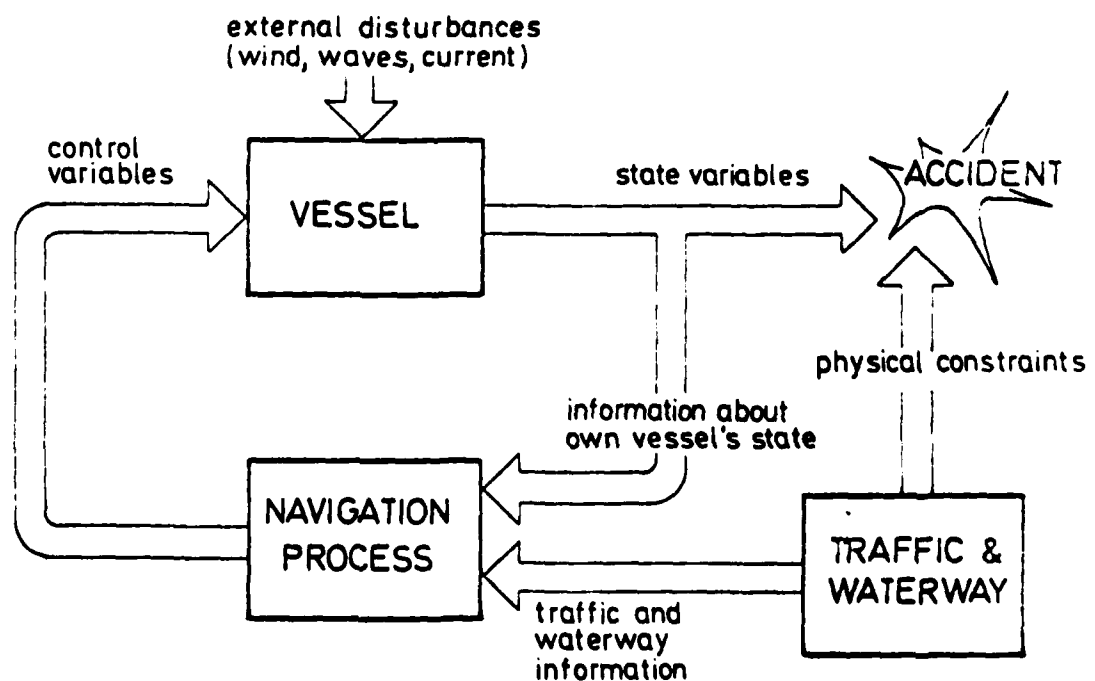


FIG. 5 MAIN ELEMENTS AND INFORMATION FLOW

The navigator is the feedback element in this system. His inputs include observations and information about his own ship's state and about the waterway. The decision process of navigation transforms these inputs to more or less adequate control variables, or decisions, that close the loop.

Of course, the decision process represented by the "navigator" box is too complex to be represented simply as a sequential input/output element. The mental activity of the navigator should rather be thought of as a number of semiparallel processes operating on a timesharing basis.

Navigation may be defined as "taking the vessel safely and efficiently from A to B". This definition immediately give rise to the identification of subtasks of navigation:

- a) Determine the vessel's position
- b) Identify and assess risks
- c) Plan future route
- d) Manoeuvre ship to desired state

These subtasks must all be adequately carried out for successful navigation to take place. In the logical diagram in Fig. 6 this is shown by an AND gate connecting the subtasks to the main goal. Each of these subtasks are then broken further down into the various steps, methods and procedures that may be needed to accomplish the tasks. The analysis is carried on to a level of detail where elements of information flow, technical instruments, and single procedures are revealed.

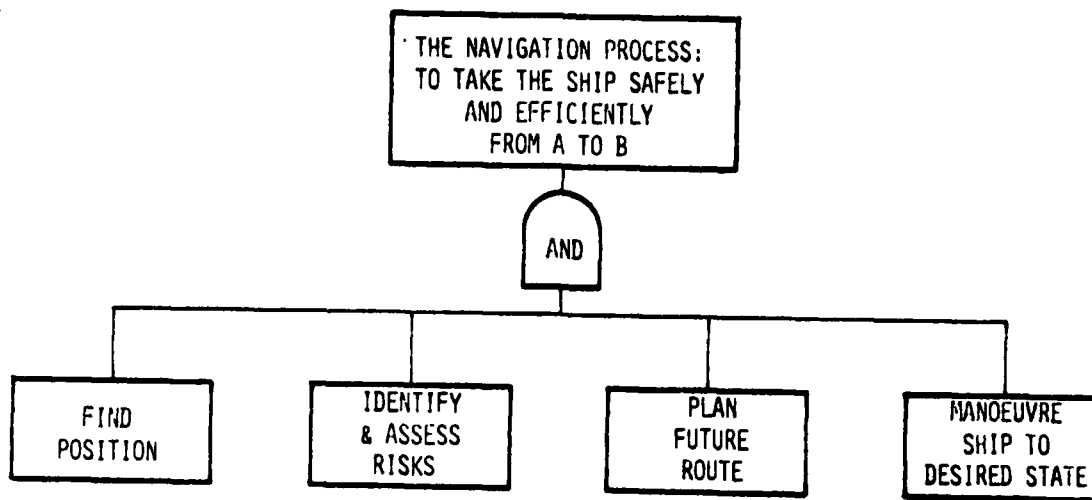


FIG. 6

More details on the modelling will be given in P.M. Wiencke's paper "A model of the Navigation Process".

The results from this subtask can be summed up as follows:

- The modelling is fundamental for understanding of the collision/grounding problem and is a common basis for the investigation and analysis of such casualties.
- The functional model of the navigation process gives a detailed logical description of the navigator's working tasks.
- The fault tree analysis gives a logical description of the potential basic failures or errors and how the logical coupling between these and the collision/grounding event is. Thus determining all potential cause relationships that can lead to an accident, is possible.
- A model of the human element may be useful in simulation studies of navigation strategies.
- The model of the navigation process may form the basis for a nautical school book.

4. ANALYSIS OF COLLISIONS AND GROUNDINGS

It was realized at an early stage that few or no data on ship casualties suitable for analytic purposes, were available. It was therefore decided to go through documentation from maritime declarations. The investigation was limited to Norwegian registered ships involved in collisions, rammings and groundings in the years 1970-78.

The analysis and findings that will be described in the paper by S. Kristiansen and J. Karlsen "Findings of the statistical analysis" should be viewed against the fact that the data originally were collected for legal purposes and therefore may be biased in various respects. The tabel below shows the main information elements.

The aim of the analysis was to identify the predominant conditions and causal factors and any correlation between these factors.

It is also necessary to point out that the data structure is crude and in some ways superfical.

Table 1 Data on collisions and groundings

Data group	Data items
Accident characteristics	Day/hour, location Ship identification, data, cargo Accident type (collision/ramming/grounding)
External conditions	Lighting Weather Wind, sea state Fairway characteristics
(Internal) manning conditions	Crew size No. of navigators Manning of the bridge Bridge watch system
Causal factors	System failures Effect of external conditions Effect of internal conditions Errors of other ships Less than adequate information Decision-errors/omissions

It was on the other hand clear that the analysis scheme had important qualities: It covers a considerable time period and the whole Norwegian fleet, and is thereby a sound basis for identifying the main characteristics of this group of accidents.

The findings of the statistical analysis will form the basis for recommendations. Status on this will be given in the paper by S. Kristiansen og J.E. Karlsen.

This subtask has resulted in:

- A database containing data on collisions and groundings for Norwegian ships for the period 1970-78.
- A statistical presentation, which should form a basis for a yearly Norwegian Ship Casualty Statistics.
- An investigation concept describing ideas to improve investigation, registration, and analysis of ship casualties.
- A revised registration form, "Report on Casualty" for collection of data from ship casualties.
- A data system concept for statistical print-outs, and on-line search for analysis purposes.
- The statistical report, and case studies could form a basis for educational material.

Fig. 7 to Fig. 10 show statistics for Norwegian ships for the period 1970-78, and Fig. 11 and Fig. 12 the prototype data system in use.

THE COMPOSITION OF THE NORWEGIAN MERCHANT FLEET.
EXPRESSED IN GROSS TONNAGE (VERITAS' REGISTER)

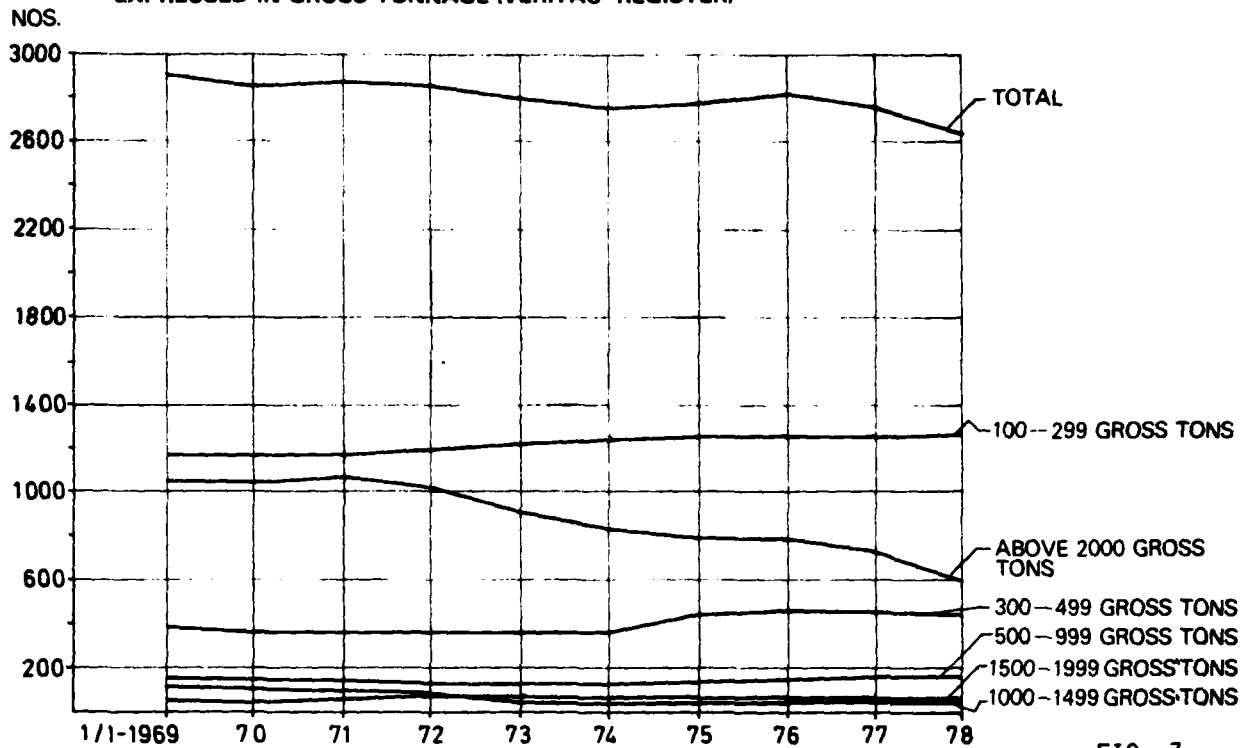


FIG. 7

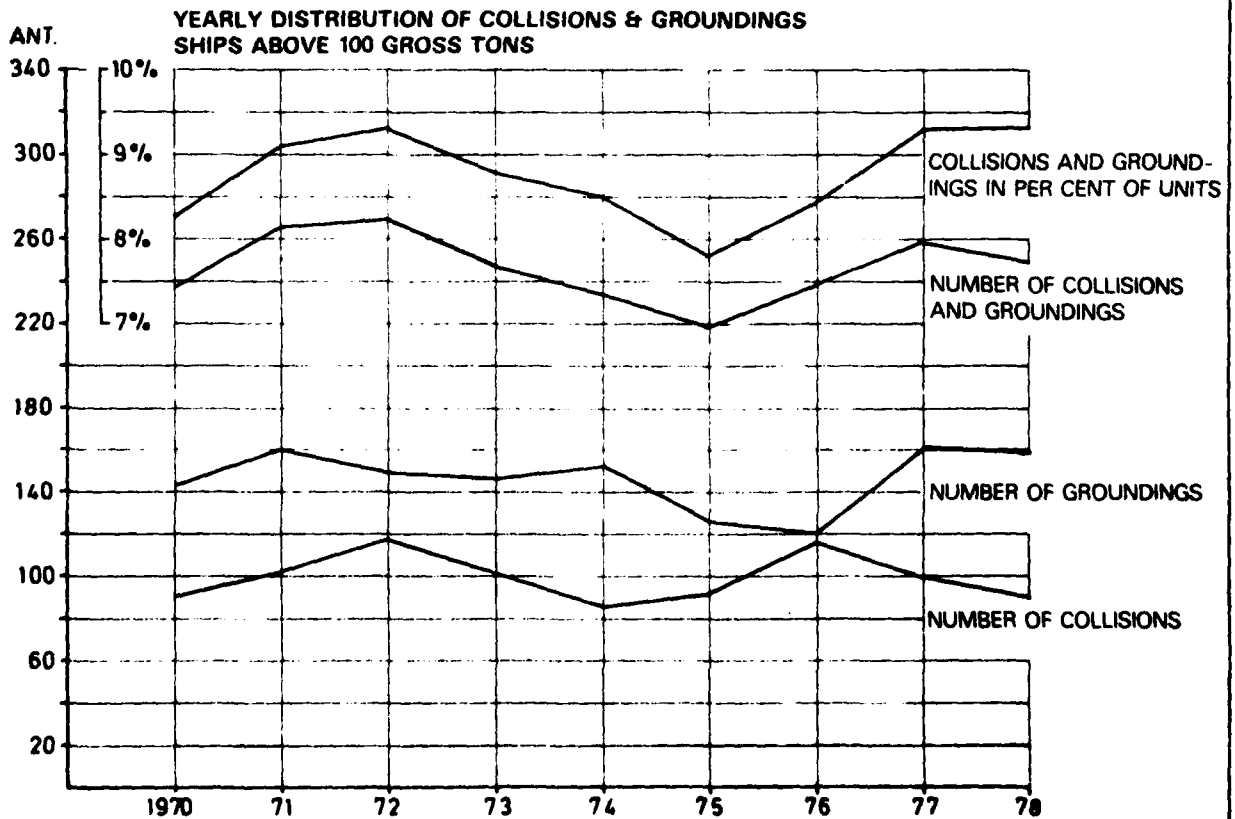
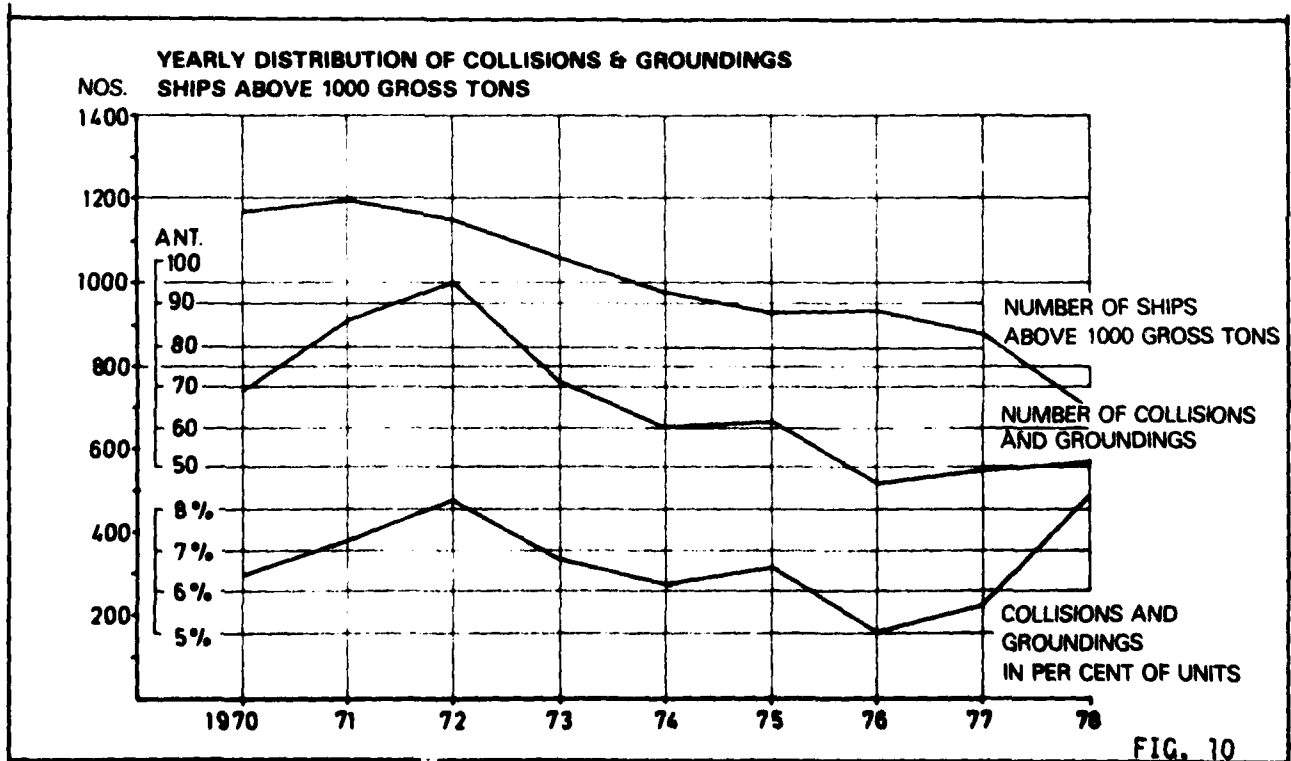
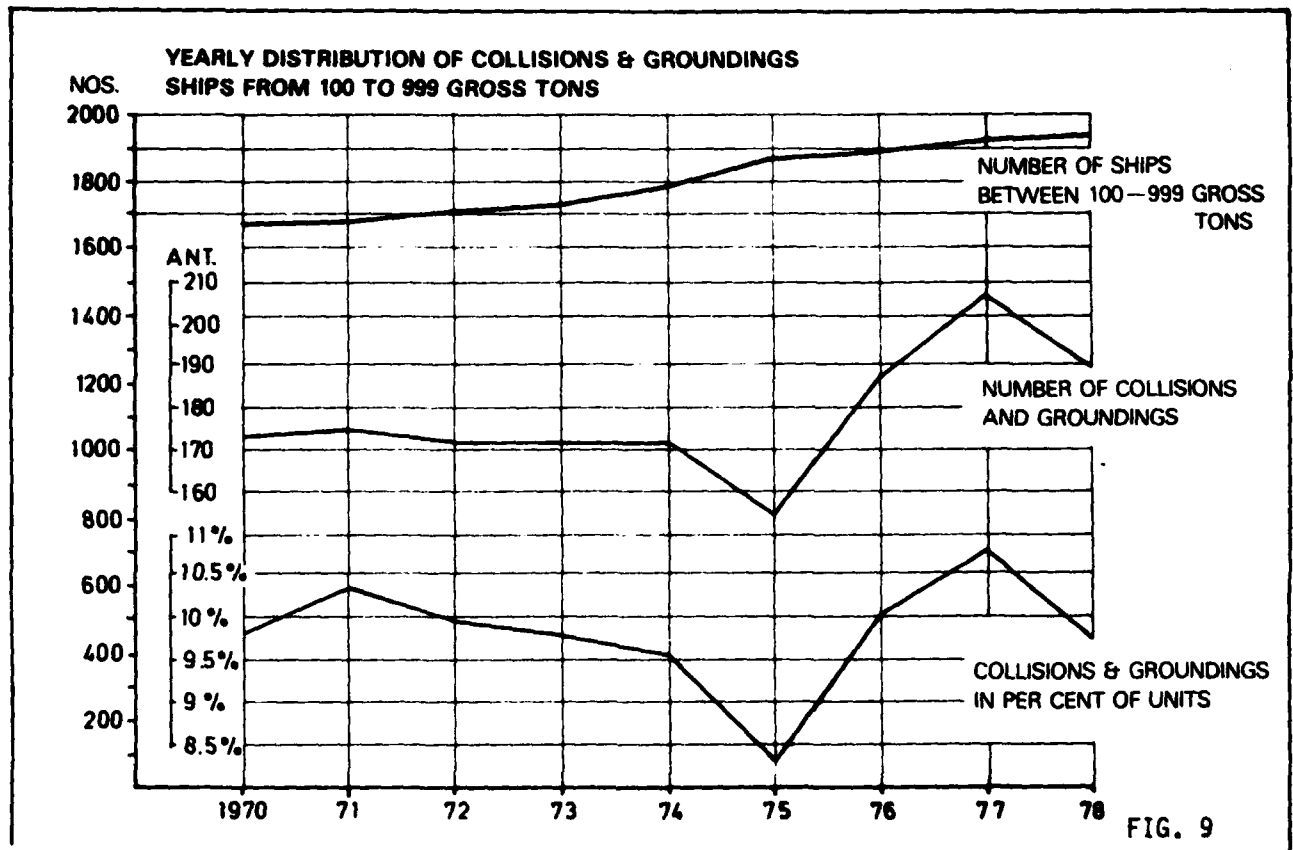


FIG. 8



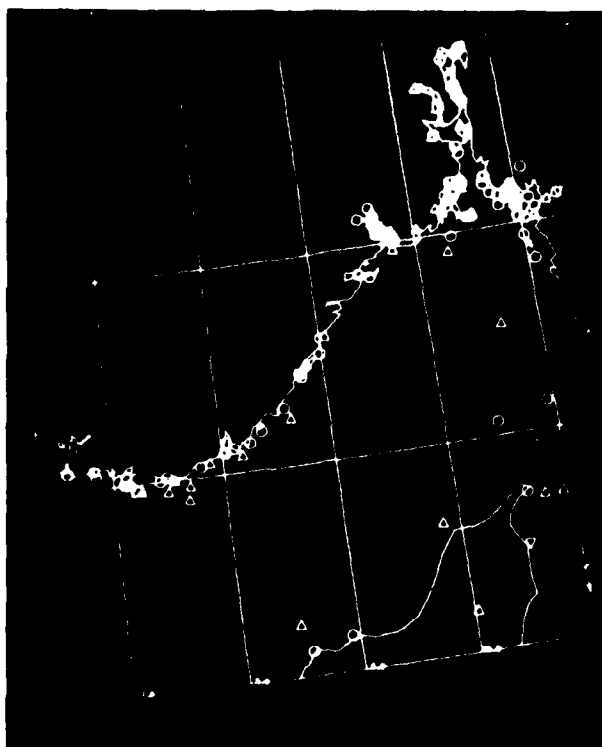


Fig. 11- Collisions and groundings for a selected area plotted on the screen



FIG. 12

5. MANOEUVRING SIMULATOR

To determine manoeuvring characteristics and their influence in accident situations, a simulator was developed, that will be used to examine manoeuvring characteristics of ships in different waters and for different conditions.

This simulator, named SAILSIM, shown in Fig. 13, is now being used for reconstruction of an accident through simulation of a tanker grounding on the Norwegian Coast. The purpose is to evaluate the risk of navigation in restricted waters, i.e. the Norwegian Coast, and form recommendations on navigational aids and navigational procedures on board, to reduce the risk.

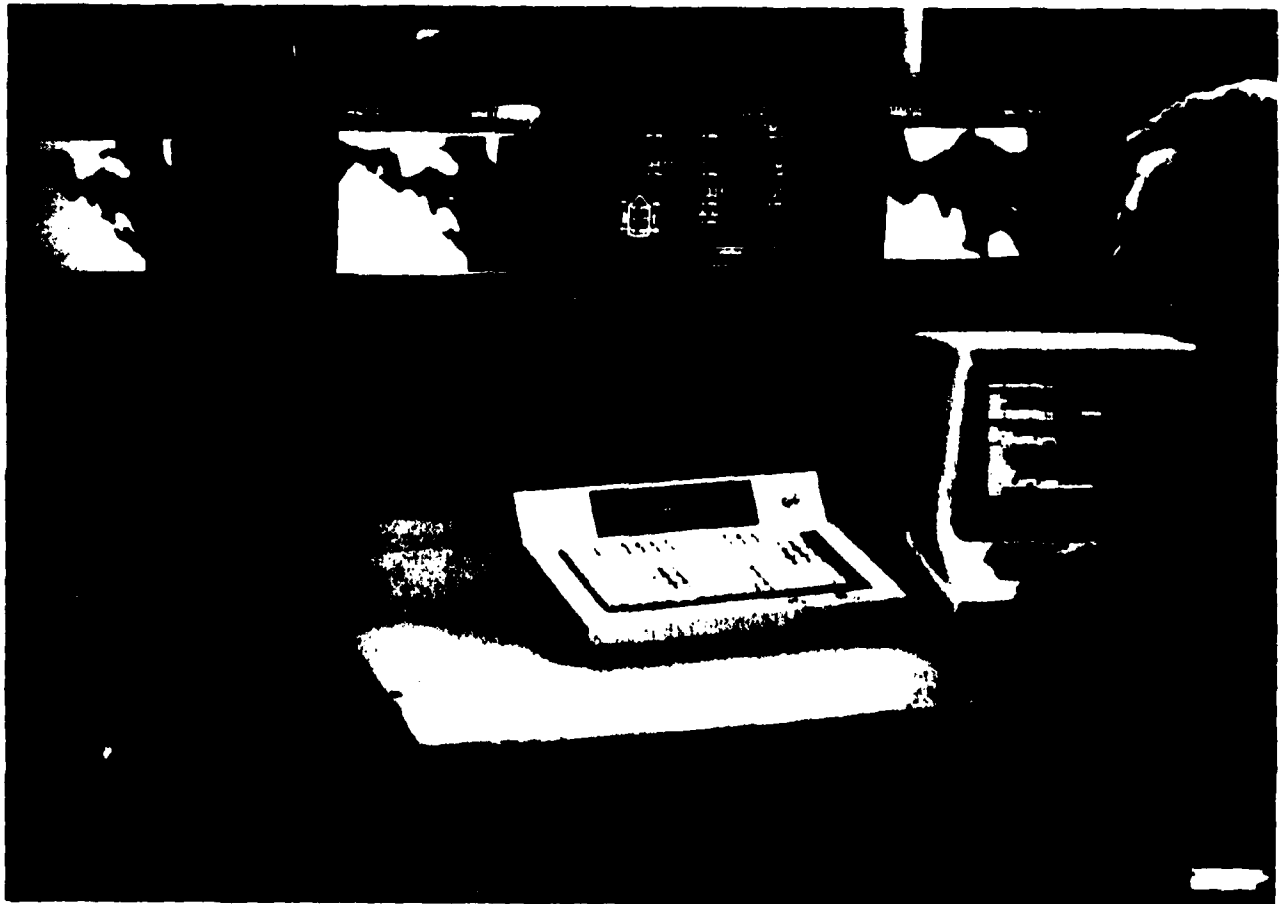


FIG. 13

To conclude, SAILSIM should be a valuable tool for:

- off-line analysis of ship manoeuvring
 - for design
 - for reconstruction of accidents
- training purposes

6. NEAR-MISS ANALYSIS

The project's initial step for this sub-task was to propose a near-miss reporting scheme as described below.

6.1 Near-miss reporting scheme

The exact number of near misses that occur at sea is not known, but the comments from masters and navigators suggest that there are a number of such instances. This represents a wealth of untapped data. There have been repeated calls for a near-miss reporting system but little positive action apart from the initial recording undertaken by the off-shore services in the Dover Strait.

In order to be statistically valid such a system would need to be international and cover all types of craft, but there is a need to start somewhere. A full reporting system would be potentially of great value in a number of different ways:

- 1) To build up a data bank of the circumstances leading to a near-miss.
- 2) To enable the effectiveness of manoeuvres and Collision Regulations to be examined.
- 3) To assist in the training of navigators.

The form suggested here is a simple first step based upon the air-miss reporting model but it will enable the project group to assess the reaction of ship crew to complete such a form and to understand the type of events reported in order to produce a rather more systematic near-miss form in the future.

EXPLANATORY NOTE TO CREW MEMBER/CAPTAIN

A number of events occur at sea which are never reported. These incidents might prove valuable in understanding more about shipping accidents. In asking you to complete this form we appreciate that it is an additional task in your already busy watch. However, from comments made to us we believe that there are often incidents which you would like to report and have had no opportunity to do so other than in the log book.

It is not easy to define a near miss at sea but we would like you to consider any event that occurs during the voyage that in any way threatens the safety of your ship. As full an explanation of the events leading to the incident, in your own words, would be of the greatest value.

We would like to assure you that no punitive action will be taken, nor will an investigation be carried out. We merely wish to understand the type of events that occur in the hope that this will help us in improving safety at sea.

We recommend that you complete the form as soon after the incident as possible and return it at your next port of call.

We thank you for your co-operation and would welcome any comments you may have on the future development of a near-miss reporting form.

INCIDENT REPORT FORM

FORM PAGE 1

Nature of incident:			
Occured at (location):			Date and time:
Own Ship:	Name:	Type:	Destination:
Other Ship or Ships Involved:	Name (if known):	Type:	Destination:
Submitted by:			
On duty as:			

REPORT

FORM PAGE 2

1) Conditions existing at the time (weather, visibility, navigation, equipment in use)

2) Nature of the Incident:

3) Action taken prior to and in avoiding the accident:

4) Suggestion as to procedures that might avoid such incidents:

5) Any other comments:

The immediate response from the navigators on the preceeding request was rather cool. Their response was that they disliked to be informers. Therefore another approach was made by a questionnaire to be used in interviewing navigators to register their opinions on the causes of collisions and groundings. The form enables the navigator to express his general opinions, and on what he believes to be the causes of casualties, or to report a near-miss, or to report his opinion of causes in an actual casualty.

Approx. 60 forms have been distributed, and 11 forms have been returned completed.

This response must be characterized as rather uninspiring, and this has also influenced the further work with this subtask.

However, the completed forms will be analyzed to see if these reports supports the conclusions from the collision and grounding analysis.

However, a near-miss reporting should have a potential success, if given more considerations and follow-up, as have been the case in this project.

Therefore the initial near-miss reporting scheme described above stands as a result still to be tried and evaluated.

7. DATA RECORDER FOR SHIPS

A question which stands central in the investigation of maritime accidents is:

To what degree does one succeed in acquiring correct and complete information on the sequence of events?

It helps very little to have an effective investigation effort and an up-to-date analysis system if one does not manage, however, to collect the correct and complete information on the sequence of events.

This is and will continue in the future to be the nucleus in maritime accident investigations, and in this connection, as in aviation, the question of the data recorder is topical. A data recorder would be able to take care of the necessary information on a ship's movements prior to an accident and record possible communication on the bridge. This would be invaluable information in being able to clear up many accidents. Such a unit could be released and float to the surface on the loss of the ship. If the data recorder did send out distress signals, one could also be able to locate it.

The project group has presented this idea before several international forums, and gradually received a broad consensus. A note was laid before IMCO by the Norwegian delegation, and the data recorder was discussed in the "Sub-Committee on Safety of Navigation" during spring 1980.

The sub-committee expressed the following opinions:

- Voice recording on the bridge would be particularly useful
- Recovery in deep water would be difficult
- Shipmasters should be protected against legal liabilities
- Careful consideration should be given to the possible advantages of recorders
- Analogy with flight recorders may be misleading
- Recording of course and speed through the water could be an initial measure
- The data recorder concept revives the question of an exchange of information on ship casualties between the different maritime administrations.

The sub-committee requested members to consider the need for a recorder and, if such a need exists, the data which should be recorded. Members were also requested to submit their comments and proposals to the sub-committee's next session.

The project group realizes the necessity for international acceptance of the idea, so that the data recorder does not become negative evidence in an economic struggle, but can give a positive contribution to explain accidents at sea and thereby give the possibility to prevent recurrences.

The project group therefore see IMCO as the right authority to follow-up this idea, because it is an international concern, and that automatic registering onboard by help of a data recorder will preserve the key information for revealing the accident. It will also act as a deterrent, and will, without doubt, contribute to reduce the number of accidents.

A Note proposal for IMCO is therefore sent The Norwegian Maritime Administration for consideration. The Note proposes to keep the idea alive in IMCO, but seen in a larger perspective, i.e. an International Casualty Investigation Group.

8. THE PROJECT AND THE MARITIME SOCIETY

8.1 The national maritime society

The project ideas was born in 1976, when both the Norwegian Coast Directorate (KD), and Det norske VERITAS applied to the Royal Norwegian Council for Scientific and Industrial Research (NTNF), for financial support for 1977 for research and development projects.

KD's idea was through investigation of ship casualties on the Norwegian Coast to analyze if lights, buoys, markers, pilots etc. was concluded as causes, and then to use the statistical findings when allocating resources to KD's different fields of responsibility.

VERITAS wanted to find out what caused the high number of ship collisions and groundings, which was dominating world wide casualty statistics, and to consider the ship rules in light of the findings and the classification societies role in the effort to reduce the number of accidents.

The recently formed NTNF-project, 3S - System for Safe Ship then asked KD and VERITAS to cooperate to form a common project with an objective which would cover the interest of both institutions.

Based on this background the project

"Cause Relationships of Collisions and Groundings"

was formed, and the whole Norwegian maritime society was invited to support the project, by participating in a hearing group (HG).

The hearing group should then be a forum for discussion and evaluation of project ideas and results and for exchange of information.

The following list of institutions reflects the support the project met in the Norwegian maritime society:

1. Norwegian Maritime Directorate
2. Norwegian Coast Directorate
3. The Directorate for Seamen
4. Norwegian Hydrographic Office
5. Royal Norwegian Ministry of Church and Education
6. Norwegian State Pollution Control Authority
7. Norwegian Institute of Technology
8. Institute of Transport Economics
9. Norwegian Shipowners' Association
10. Norwegian Shipmasters' Association
11. Norwegian Mates' Association
12. Norwegian Seamen Union
13. Norwegian Pilots' Association
14. The Norwegian Association of Nautical Experts
15. Norwegian Mutual Hull Clubs Committee
16. The Central Union of Marine Underwriters
17. Civil Aviation Administration
18. Nordic Institute for Maritime Law
19. Royal Norwegian Council for Scientific and Industrial Research
20. Royal Norwegian Navy
21. Central Bureau of Statistics
22. The Ship Research Institute of Norway
23. Norwegian Coastal Liners' Association
24. Norwegian Society for Sea Rescue
25. Norwegian Coastal Freighters' Association
26. Det norske VERITAS

The hearing group has been a valuable resource for the project group and an effective way of spreading information. For a research project, it may be questioned if such an overhead organization may slow down the research progress, and that the debate may be destructive because of organizational or political issues. However, in this case the opposite must be advocated. By exposing ideas continuously for such a critical group and asking opinions, many facets of ideas are revealed and the conclusions and results are understood and in the most cases accepted before project documentation. This has also forced the project to be highly result oriented, and being able to deliver and incorporate results within the project's duration. It was also felt that the project's willingness to expose the research underway, was welcomed positively from organizations in the maritime society, who seldom was asked their opinions in similar projects. This created the positive atmosphere, which has been very stimulating for the project.

The financial support has been very good, totalling about 5.1 mill. NOK for the project period 1977-80, with the following contributions:

	(1000 NOK)		
Norwegian Maritime Directorate	275		
Norwegian Coast Directorate	816		
Norwegian State Pollution Control Authority	275		
Leif Høegh & Co. A/S	54		
NTNF-PFO	1570 {	325	
NTNF-SK			110
NTNF-3S			1 135
NTNF			
The Central Union of Marine Underwriters	50		
Det norske VERITAS	<u>2 028</u>		
Total	5 168		

8.2 The international maritime society

The Norwegian maritime society has been heavily engaged in the project as reflected above.

However, "Safety at Sea" is an international concern, and therefore the project ideas also have been exposed internationally through papers and presentations, and have been met with interest.

IMCO has been an important target for exposure of project results. As described above, the concept of a data recorder for ships was introduced for IMCO, and is now been given the necessary international considerations, to see if it can be a valuable tool contributing to increase "Safety at Sea".

This year a steering group on casualty statistics was formed in IMCO, which met first time during Maritime Safety Committee's 42nd session. Norway was represented in the steering group, and the project's report "Statistical survey of collisions and groundings for Norwegian ships for the period 1970-78" was discussed in the group, and the report will also be considered by the Sub-committee on Standards of Training and Watchkeeping at its next meeting.

Especially three important aspects of a world wide casualty statistics was inspired by the project results:

- Extend the IMCO casualty statistics for ships other than tankers above 10000 grt.
- To register the causes of the accidents. Present databank records only accident picture, circumstances and consequences.
- To develop a suitable report form which might be used internationally to be filled in after a casualty.

It is felt that the international maritime society welcome the exposure of the project, and that it will initiate other activities leading to international cooperation in this area.

9. CONCLUSIONS AND OBSERVATIONS

The project is at present in its concluding phase, and it is at this stage only possible to indicate project conclusions.

It seems right to recall the project's main objective before summing up:

"Through studies of the error mechanism in manoeuvring and navigating which leads to collisions and groundings, recommend means by which to reduce the accident frequency".

This is an ambitious goal, which the project will answer in the following way:

- List of recommended measures for different tonnage groups.
- List of project achievements, being a basis for recommendation on measures.
- General project observations.
- Proposals on follow-up.

9.1 List of recommended measures

A preliminary segmentation of the data is done as shown below:

<div>Tonnage Casualty type</div>	<100 grt.	100 - 1599 grt.	>1599 grt.
Groundings	11%	40.6%	8.4%
Collisions	25.3%		
Rammings	7.2%		

The recommended measures will then address the different groups as shown in the preceeding table.

As an example the following list propose recommended measures for ships greater than 1599 grt. in order to reduce the number of groundings in restricted waters in the future.

Areas of concern	Recommended measures (keywords)
Navigational aids	<ul style="list-style-type: none">• Racon• Systems for precision navigation• Lights, bouys, marks:<ul style="list-style-type: none">- light brilliance- position- application
Bridge systems	<ul style="list-style-type: none">• Radar<ul style="list-style-type: none">- properties- reliability• Optical aids• Integrated/computer based plotting aids• Conning position for contact navigation
Personnel/competence	<ul style="list-style-type: none">• Coastal navigation training• Communication training (pilot-navigator)• Manoeuvring simulator training
Bridge procedures	<ul style="list-style-type: none">• Planning of night sailing• Planning of coast sailing• Briefing of navigator• Orders/instructions from master• Watch manning• Procedures for piloting• Cooperation pilot - navigator• Double check of marks and lights• Plotting of kept course• Alternative position fixing references• Procedures for reduced visibility sailing

Explanations and more details will be given in paper by Karlsten and Kristiansen.

9.2 List of project achievements

The project has been a diversified activity, and when searching for measures for 4 years, quite a few "spin-off products" may be claimed as important results, both operational system and system concepts.

- A logical model of the navigation process may be used as a basis for a nautical school book.
- A model of the human element may be used for simulation studies.
- A casualty data base.
- A statistical presentation concept for ship casualties.
- A casualty investigation concept.
- A casualty registration form "Report on Casualty".
- A data system concept.
- Casualty statistics and accident cases as a basis for courses in accident prevention.
- An off-line simulator of ship manoeuvring.
- International discussion in IMCO on data recorder for ships.
- Contribution to the discussion on an IMCO casualty statistics scheme.
- Institutional cooperation on investigation of casualties.

9.3 General observations

During the project period some general observations have been made by the project group. It is felt to be of importance to communicate these observations, and below is listed areas, which will be covered in the project's final documentation.

- Responsibility for and the enforcement of safety for navigation.
- Investigation of casualties and criminal prosecution.
- Maritime Accident Commission.
- Analysis of accident data.
- The maritime declaration and the truth v.s. a data recorder.
- Safety and manning.
- The Marine Underwriter's role and responsibility for safety at sea.
- IMCO and international responsibility for enforcement of safety at sea compared with ICAO (aircrafts).
- Training and refreshment courses to maintain the navigators necessary level of expertise.

9.4 Follow-up

In 1977 the project's main objective and goals were formed. The project period was estimated to 4 years and a funding of about 4 mill. was agreed.

The project is finalizing this year. The project has done its best to fullfill the objectives and reach the goals. The project costs are about 5.1 mill.; 1.1 mill. more than estimated.

It is now important that the project's recommendations and observations are considered seriously by the institutions responsible for the particular areas concerned.

Furthermore it is important to continue the work for "Safety at Sea", and the final report will recommend areas to follow-up and fields to dig deeper into.

For follow-up projects the below recommendations is experienced to be of vital importance:

- National coordination
- Cooperation by parties involved
- International discussion and cooperation
- Action on recommendations by responsible institution

10. ACKNOWLEDGEMENT

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